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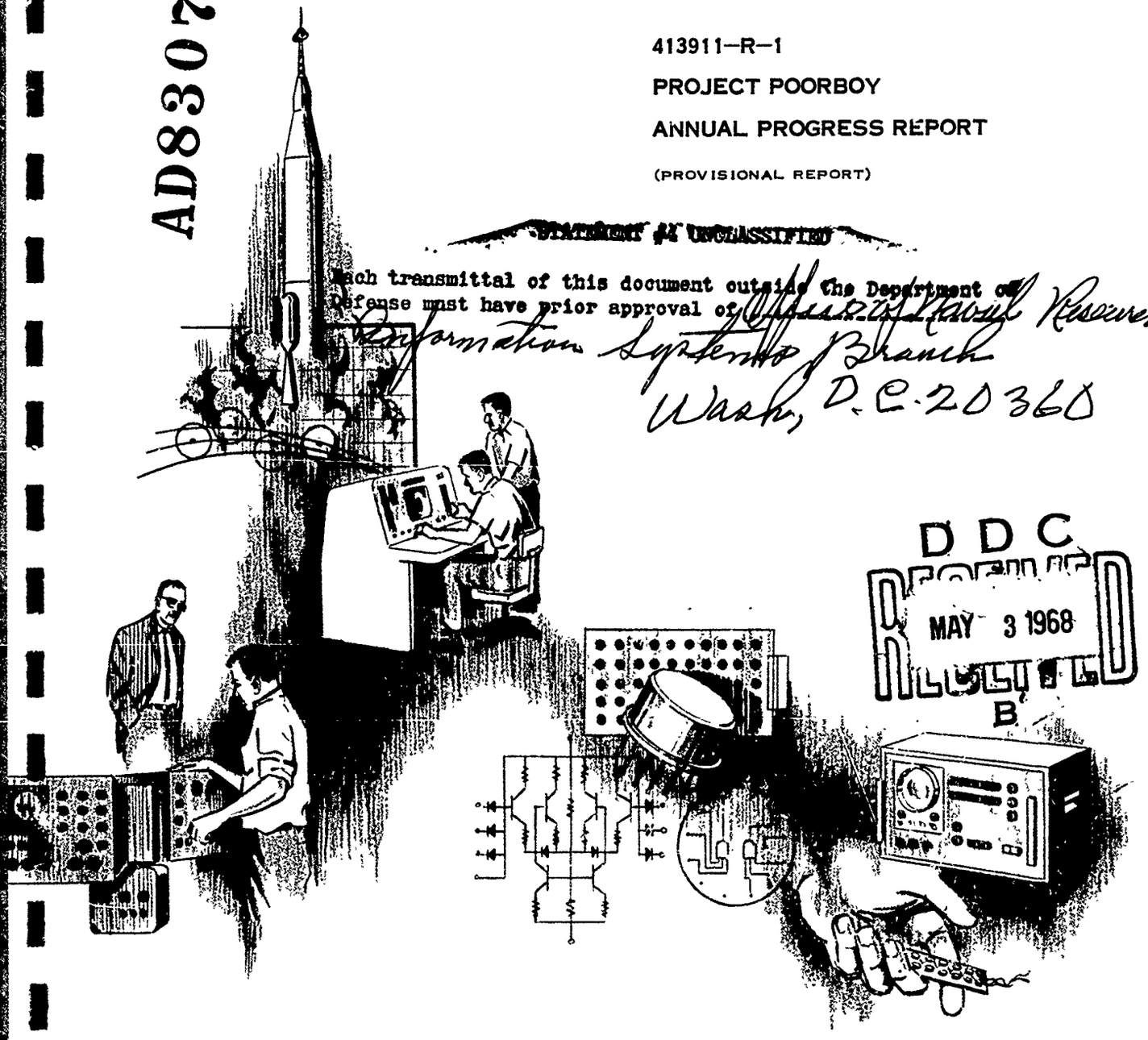
PROJECT POORBOY

ANNUAL PROGRESS REPORT

(PROVISIONAL REPORT)



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PROJECT POORBOY

ANNUAL PROGRESS REPORT

(Provisional Report)

Report Number 4139.11-R-1

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FOREWORD

As its title implies, this report describes the progress of Project Poorboy over the past year in attending to certain concerns of intelligence and operations in limited war.

This report combines a historical statement of activities under the project during the year with a resume of technical progress.

The reader who is concerned solely with the technical results of the project is encouraged to skip over the first sections dealing with the conduct of the activity and to begin his reading at Part IV (page 12) "Report of Action Taken and Provisional Findings."

As with prior reports based on this project, technical feedback is solicited. Commentary and queries may be directed to either the project sponsor -- the Information Systems Branch of the Office of Naval Research -- or to the contractor as shown on this report.

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I. INTRODUCTION

A. BACKGROUND

Project Poorboy has been in existence as a formal project under ONR contract N00014-67-C-0349 since May of 1967. It is this past year's activity to which this report is addressed. However, ONR sponsorship of the research concept embodied in Project Poorboy antedates by at least three years Poorboy's formal operation as a project. As early as 1964 the contractor was encouraged by Mr. Richard Wilcox and later by others of the Information Systems Branch of ONR to innovate quick-fix, interim, and inexpensive solutions to problems of naval intelligence. Although the activity has grown in both size and scope, the fundamental philosophy remains -- provide simple, low-cost and timely solutions to current needs.

But, while the fundamental philosophy has not changed with time, the area of applications has. Originally applicable to intelligence problems associated with antisubmarine warfare, Poorboy activities were expanded to include other naval intelligence concerns. Later, this was broadened to include operational considerations, especially where these might have intelligence relationships. Still later, Poorboy attention was directed to concerns of limited war regardless of sea, air, or land context in an attempt to assist directly the U. S. effort in Vietnam. In doing this, Project Poorboy also became concerned with the information system which links the research with the operational community in the Poorboy subject area.

B. EFFECT OF THE BACKGROUND ON THE RESEARCH

In hindsight, it can be said that the mutations of applications through which Project Poorboy has passed are the result of changing conditions. But it would be more complete to say that these changes have come about as a result of the interaction of these changing conditions and at least two additional factors: (1) the belief (not easily defined and almost intuitive) on the part of ONR's Information Systems Branch leaders that here was a needed area of research, the successful pursuance of which might help to bridge the gap between the researchers and the operator at the working level, and (2) the research performed by the contractor during which new problem areas were uncovered, leading to extension of research into these areas.

Since the nature of the problem areas to be investigated not only changed with time, but was somewhat subjective in the first place, Poorboy goals were and are necessarily stated in general terms. This dictated that the more elegant scientific approaches which start with a precisely defined problem and proceed in clean-cut increments through carefully structured experiments to incontrovertible conclusions could not be used in Project Poorboy. Rather, what has been used to bring problem and solutions together has been a combination of brainstorming, trial and error, and congruency matches between problems and solutions.

This approach, which can be dignified for the erudite reader by labeling it "heuristic," has enabled Poorboy to operate somewhat as a combination vacuum cleaner and variable filter among both problems and solutions. For example, Poorboy research omnivorously swallows into its maw anything

that looks like a problem. It then passes the substance through several filters which separate on the basis of such descriptives as: limited war? naval? intelligence or operations? likelihood or unlikelihood of sophisticated answer in the near term? or amenability to solution via Poorboy philosophy?

The product of this approach may be an idea, a procedure, a study, a device, or a combination of these. If a device, it is likely carried only to the feasibility prototype stage, since quantity production is beyond the purview of Poorboy, except perhaps for simple information aids. It is possible that the research product may consist solely of an indication of a commercial or an already in-stock military device or system which would fit the need. (Poorboy is dedicated to using off-the-shelf capability without modification when possible.) Or the Poorboy product may be the delineation of problems or the identification and definition of the information system by which the problems are surfaced.

Many of the various research product forms are reflected in this report since the past 12 months' effort represents a microcosm of all that has gone before and, at the same time, represents excursions into new areas of investigation as well. Because much of this work is of a continuing nature, this report has been labelled "provisional". The research results of individual sub-projects are likewise provisional in many instances. Therefore, this report may be considered more of a status report than a final report of investigation or research.

Individual actions and solutions are treated in Annexes hereto. However, two especially troublesome areas require special treatment and are of special concern. These deal with (1) the "problem of identifying problems", and (2) the information system by which problems are surfaced and through which they reach the R & D community for action. These are discussed in Parts II and III which follow.

II. RESEARCH INTO PROBLEM SOURCES AND SELECTION

A considerable portion of the energies expended in the first six months of the period covered by this report was spent in seeking to identify problems for Poorboy attention.

The chronology of activities performed under this heading and a statement of problems uncovered are covered in considerable detail in the semi-annual status report of Project Poorboy dated 15 November 1967 and will not be repeated here. However, certain pertinent excerpts from this document are quoted below.

"(A) Efforts to identify problems were made under several headings:

(1) Visits to selected combat development centers and command headquarters concerned with tactical operations.

(2) Visit to Southeast Asia for on-the-spot contact with problem sources.

(3) Showing and review of DOD film ('Toward Victory in Vietnam') which highlighted major problem areas.

(4) Documentary research and literature search.

(5) Interviews with recent returnees from Vietnam.

(6) Contact with concerned individuals and organizations at the operational level."

"Of these approaches, one proved to be a serious disappointment, expecially since it was the most promising scheme for identifying current problems for Poorboy attention. This was the trip to Southeast Asia, with a stopover at PACOM, to gain firsthand acquaintanceship with the problems, the geophysical conditions under which these problems obtain, as well as the means and media by which such problems are recognized and reported.

. . . . . Unfortunately, the trip was disapproved . . . and the expected results had to be sought in other ways."

"In any event, its cancellation resulted in delays in gathering live information and increased the need for processing information obtained later by other means for currency."[1]

"The film 'Toward Victory in Vietnam', narrated by Dr. John Foster of D.D.R.&E., was obtained and shown to over 80 selected scientists and engineers at the contractor's facility. . . . The dozen responses in terms of ideas is gratifying. Two of these suggested ideas are already the subject of current Poorboy investigation."

"Highlights of other activity included visits to the USMC Landing Force Development Center, Quantico, Virginia, . . . and to Beach Jumper Unit #2 of the Naval Amphibious Base, Little Creek, Virginia, . . . This meeting produced a number of problems, three of which are receiving Poorboy consideration."

"The [first] meeting with Beach Jumper Unit #2 . . . [at which] single specific problem, introduced by the Commander of the Beach Jumper Unit, was selected for Poorboy attention as typical of that unit's immediate problems. This problem was researched by HRB-Singer, Inc. engineers and a formal response generated and forwarded to the Beach Jumper Unit."

"Still another source of problems has been individuals returned from duty in or visits to Vietnam. One of these individuals, . . . made available to Project Poorboy investigators information from his inspection trip report to Vietnam. . . . From these data additional problems were identified, two of which are receiving Poorboy attention. These [other] contacts were made both personally and via correspondence."

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[1]Underline added.

"Another marine officer on duty with ONR . . . provided Poorboy representatives with comments made by General Walt upon his return from Vietnam where he commanded all USMC forces there. From these comments currency of some of the problems was determined and two new problems introduced."

"(B) Screening of problems for Poorboy attention was based on a review of the problems derived from the aforementioned sources. This review, together with other inspection of 'the literature' and other sources, leads to the conclusion that a wholesale attack on these on a broad front would probably reproduce in part the work of others already done or underway.[1] No such luxury is possible or desirable under Poorboy. Consequently, a selection based on two screening processes has or is being applied to the list of problems to further identify those to be pursued under Project Poorboy."

"The first of these processes is screening based essentially on answering the question: 'From how close to the source of need does the statement of the problem come?' . . ."

"The second screening process is applied where the source of the statement about the problem and the source of the problem itself are not synonymous . . . In such cases the question, 'Is this still a valid problem?' cannot be answered directly because the personnel making the statement are not (or are no longer) directly involved. Here it has been necessary to search out individuals, offices, or organizations who may be cognizant of the status of the problem and solutions in work or completed. Several of these information sources have been identified in [such places as] ARPA, in Opnav (Developments), in DIA (R&D), at the U. S. Army's Limited War Laboratory, at the USMC Landing Force Development Center, and at the Battelle Memorial Institute."

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[1] Underline added.

It can be seen from the foregoing that identifying problems and subsequently screening them for possible Poorboy application is a rather hit-or-miss affair. The situation defies an organized approach largely because of two factors: (1) Many of the problems are of such a nature as to preclude their being stated voluntarily or formally, and (2) the channels by which such information flows to organization/action centers are quite limited.

On the first point, it appears that the "system" simply does not encourage the surfacing of "small" problems. It is necessary to contact possible sources (persons) of problems, gain their confidence, and encourage them to discuss their operations. In the course of such discussion then, problems appear which would otherwise not be surfaced or if surfaced would not be further noted. Because this deficiency is especially apparent in the general subject area of naval intelligence -- the ultimate objective of Poorboy attention -- the origination of means to better detect and define naval intelligence problems (and some operational problems) has become a Poorboy problem in itself. Thus far, the nature of a system or scheme which would expedite and encourage the expression of problems is not clear. Perhaps some approach such as the use of taped interviews (as currently being accomplished by the USMC) would be of advantage since most individuals are more willing to <u>talk</u> about their experiences than to <u>write</u> about them. At any rate this entire subject requires further investigation on a priority basis.

III. A NEED FOR RESEARCH INTO THE INFORMAL INFORMATION SYSTEM

As with the subject of problem disclosure and identification, the means (or lack of them) by which problems, once surfaced, are reported and passed to action offices and by which follow-up is accomplished needs investigation and research aimed at determining the most expeditious modes for such effort. Though this subject has not received direct Poorboy attention thus far, the informal information system needs much better definition and a close examination of its working processes in order that its use be optimized. This is especially important in naval activities related to operations in Vietnam since formal mechanisms for detecting and noting problems of intelligence and operations there do not appear to exist as in the case of ACTIV teams of the Army, the combat interview system of the USMC and the Southeast Asia centers of the USAF at Eglin and Wright-Patterson Air Force Bases.

From related information already gathered in the course of Project Poorboy investigations (which have been largely directed to the area of the "non-project"), it is expected that only very limited formal reporting mechanisms exist for the "non-project" type of problem. Even these may be ancillary to some other application. For example, the USMC publication, "Professional Knowledge Gained From Operation Experience in Vietnam" is used not only in the application that its title suggests, but by some research and development entities to "identify" problems for attention.

But, lacking the prestige of the "project" problem, the "non-project" problem is likely to be treated in a very informal manner. This suggests that the information regimen will not fit the standard or normal conception. Informal information systems have been studied very little, but since this

is the principal route by which many of the "non-projects" are surfaced, some pioneering and innovation will be necessary.

The situation, as apparent from Poorboy contact with informal information system interfaces, again relates primarily to the "small" problems. This, in turn, can be defined as one not articulated or championed by a flag rank person or one in which the probable solution does not fall into the category of a program or a weapon system. At the moment many of these problems are passed forward through the "old buddy" system; some come to the attention of appropriate military action offices through strong press publicity (the M-16 rifle for example), some through unscreened comments made by returned combat personnel. It is surprising how much has been learned about operating deficiencies through letters written home which later were passed into the hands of the appropriate Senator or Congressman.

These considerations have proved applicable to the special case of R&D support to Vietnam (and limited war). They are reflected in the frequent statements and intimations in the popular press that the full weight of American scientific and technical resource is not being marshalled to deal with the problems of conducting war in the environment of S. E. Asia. From an examination of these reports, it became apparent that, with a few exceptions, the larger, more prestigious problems received an inordinate share of research and development attention, much to the detriment of the lowly "non-projects", even though these be highly important to the combatee.

These information channels are too unreliable, however, to provide adequately for the flow of problems. They can be likened to the S.O.S. message in the bottle tossed into the sea which some day may, but likely will not, arrive at an intended destination. Yet these appear to be the only functional communication systems for many of the problems. Considering the

number of problems which are successfully passed in this manner, one cannot but wonder at the truly large number that must constitute the other not-heard-of 99%.

Dr. Robert A. Frosch, Assistant Secretary of the Navy (R&D), commented on this curious fact in November, 1967 as follows:

> "There is a great tendency for identifiable programs that meet requirements to receive a great deal of attention. 'And yet,' Frosch said, 'there are important items that may get only cursory attention. There are many areas that have a large payoff for the Navy but, because they are neither designated projects nor weapons systems, they have no 'person' to speak for them. Consider, for example, the improvement of ships' boilers. Keeping boilers clean demands a lot of work. If we can find some ways to simplify that, it will mean a great improvement in the fleet. One of the things I want to do is identify these areas of 'non-projects' and stimulate useful work on them. We will have really accomplished something if we can isolate some of these problems, study them successfully and come up with an improvement for the fleet.'" [1]

It can be seen that Dr. Frosch is aware of the deficiency in Naval R&D in dealing with these problems in the category of Poorboy. He is also hopeful of stimulating useful work on them. These comments by Dr. Frosch are especially encouraging. An in-fact extension of his philosophy into the working machinery of Naval operational intelligence would appear to do much to alleviate the situation insofar as naval intelligence problems are concerned. Project Poorboy will address this investigation with considerable vigor in the future.

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[1] The Honorable Robert A. Frosch, Assistant Secretary of the Navy (R&D), speaking in "How the Budget Process Affects Service Development Goals," Armed Forces Management, November, 1967. (Underline added.)

IV. REPORT OF ACTION TAKEN AND PROVISIONAL FINDINGS

From the approximately three dozen specific problems identified as a result of liaison performed during calendar 1967 about one-third received varying degrees of Poorboy attention. The effort was, in all cases, characterized by an attempt to find an already existent solution first, followed by attempts to modify possible solutions so as to achieve a better match with the problem. In still other instances a survey of existing related knowledge was made and/or new solutions innovated. In some cases commercial products which would appear to fit the need (based on their reported technical specifications) are suggested as answers, subject to procurement and testing of samples by the appropriate R&D center.

A summary brief on each of these actions follows. Where appropriate, additional reference is given to Annexes or to previous reports which constituted a report of finding. In each case, the summary starts with a statement of the problem and a descriptive short title for quick identification.

A. Low Frequency Vibration. This investigation was directed to the use of infrasound as a possible weapon for conditioning Viet Cong tunnel inhabitants. Infrasound is defined as "low frequency" generally below 50 hertz (hertz = cycles per second) and especially below the limit of human hearing at about 16 hertz. This is in contrast to ultrasound running from about 20,000 hertz upward and beyond the upper limit of human hearing.

The solution being sought was a field implementable scheme which would (1) drive out, (2) render impotent or neutralize, or (3) significantly mark for later detection, Viet Cong tunnel inhabitants. The objective was to

minimize the dangers to the U. S. "tunnel rat" in exploring and searching Viet Cong tunnels for intelligence information, arms, supplies, and, of course, the enemy.

The use of ultrasound in this connection was suggested as a result of an accidental introduction of low frequency sound from a nearby generator room during some shelter-stress studies performed by the contractor in conjunction with some work for the Office of Civil Defense.

The subjects in the shelter, who had been in darkened confinement for two days, experienced noticeable psychological and possibly physiological perturbation as a result.

Since a series of full scale psychological and physiological experiments is not within the purview of Project Poorboy, a documentary research effort was accomplished into this subject area. The detailed result of investigation is given in ANNEX A.

The findings are summarized as follows:

1. Infrasound does affect the human organism both psychologically and physiologically.
2. Frequencies in the area of resonance of human organs, 3-15 hertz, appear to be more critical than other segments of the infrasound region.
3. The distinction between low frequency sound and vibration is not clear.
4. There exists a paucity of documentary evidence about the effects of severe infrasound on the human organism.
5. That information which is available suggests that infrasound may have greater effectiveness as a weapon than ultrasound, which has been examined considerably on this premise.

B. Counter Intruder Fibres. This investigation was directed to the problem of denying or rendering inhospitable, those areas in which an enemy might seek refuge or through which he must pass in order to infiltrate guerrilla forces or supplies. Although the technique and substance recommended are not absolute (in that they do not effect an immediate barrier), they do provide a means of identifying trespassers, of causing irritation and incapacitation as time progresses without engendering cries of bacteriological or chemical warfare.

The study which is given in detail at ANNEX B describes the use and limited testing of small glass fibres and methods of deployment as an anti-infiltration device. A copy of this study, together with a sample of the materials, were provided to the USMC Landing Force Development Center on 9 August 1967.

Essentially, the report concludes that the use of the fibres is technically feasible and efficient in this application, but that operational considerations will restrict its use to those areas for which friendly access is not required for some time. Specific conclusions are given at ANNEX B.

C. Folded Monopole Antenna. One of the most recurring of the specific requests for R&D support of field operations in Viet Nam has been the plea for a less conspicuous antenna for the PRC-25 and similar field radios. The present long whip monopole is too readily seen and targeted by the enemy in a fire fight, thus making for a high casualty rate among radiomen and the senior NCO's and lieutenants who use the radios.

There is considerable research in antenna design, especially leading to miniaturized antennas in the U. S. R&D community. To date, however, no

efficient miniaturized antenna has been developed except for a "receive only" innovation of the Air Force Laboratories at Wright-Patterson AFB. This antenna operates in a limited portion of the VHF range.

Thus, while the R&D resources of the nation are engaged in trying to devise a satisfactory solution, the Viet Cong and North Vietnamese continue to use the long whip antenna as a target position indicator.

As an interim solution, Project Poorboy research points to the commonly available folded-monopole. This antenna achieves a physical shortening of the whip by folding, or,in most cases, coiling, up to two-thirds of the length. It is frequently seen on police or other emergency vehicles where the long whip would be impractical. But while the physical dimension is considerably shortened, the electrical length remains unchanged and, hence, the antenna remains operative in the frequency regime of the original whip. There is, however, some degradation of technical performance, typically on the order of 7 to 10 per cent of range.

In the jungle regions of Vietnam where communications are already difficult this degradation can be serious. On the other hand, degradation of performance caused by the fact that the radio operator is dead or that the radio has been shot up because the long whip antenna makes it a target must be considered in the trade-off. Possibly, the folded monopole and the whip could be attached to the field equipment with the whip in the stored position unless absolutely needed to gain the additional range and then only when the operational situation made the trade-off riskworthy.

Obviously, the inputs to this trade-off will vary with each operational situation and the decision must rest on human judgment and assessment at the time. The folded monopole, as an interim solution, at least provides the unit leader with a choice of alternatives.

D. Electrified Fence/Cut Fence Alarm. These two requirements stem from the need expressed by Gen. Walt, USMC, following his tour as Commander of all USMC forces in Vietnam for (1) a scheme to electrify the concertina wire used on defense perimeters (to discourage Viet Cong from cutting the wire), and (2) an alarm device to indicate when the wire had been cut.

From a Poorboy point of view and as an interim, off-the-shelf capability to satisfy the first requirement until a more sophisticated approach can be developed, Poorboy research suggests the use of electric fence "chargers" (used to control livestock on farms), in conjunction with coating the wire with a dielectric material sufficient to minimize its direct contact with the ground. Such a coating need be only a few mils thick and can be sprayed on or dipped on in the field or dipped on during the manufacturing process. This will not preclude leakage of the energy from the charger to the ground via the wire, but will greatly reduce it. More importantly, it will create a situation where a pair of wire cutters incising into the wire from the hand of a Viet Cong lying on the ground will provide a better circuit to ground than the coated wire itself. The 2,500 to 4,000 volts delivered by the class of fence chargers designed to shock through wet weeds and grass is sufficient to discourage any bare-handed (or even lightly insulated) Viet Cong from cutting the wire. Most of these fence chargers are considered effective for up to several miles of wire, however, in view of the considerable leakage resulting from the fact that concertina wire is laid on the ground and pegged (the coating prevents only direct contact) it is recommended that not more than a few hundred yards be connected to one charger. Battery powered models, as well as 110 volt AC models are available at most agricultural supply houses who, in turn,get them from electronics suppliers.

As to the alarm mechanism, several off-the-shelf possibilities are suggested as a result of Poorboy research. Perhaps the simplest technique is to use a volt-ohmeter as a continuity tester on a finite section of the wire. This equipment is most lilely to exist in the motor pool, the armament and electronics shop, or the communications unit. In this scheme, insulated leads run from each end of the wire to be protected to the continuity meter. (Although not essential for successful operation, it is highly desirable that the perimeter wire be coated, as above, to increase life of the internal battery in the circuit -- ohm -- meter.) Once connected, the normal meter reading should be noted and/or marked on the face of the meter with a grease pencil or similar. During periods of darkness and low visibility, monitoring of the meter will provide a constant check on the continuity. If the wire is cut or broken, the indicator will go off the scale toward infinity. Since the section of wire subtended by the meter is known, the sector of the perimeter in which the wire was cut is also immediately known.

Variations on this basic scheme -- continuity testing -- are largely in the form of devices which provide automatic monitoring at the recorder and flash a light or ring a bell when the circuit is broken. No special device was developed under Poorboy for this purpose, there being numerous commercially available burglar alarms and industrial limit alarms for this purpose. One such device is the "Humdicator" -- an audible circuit test indicator produced by the CIRCON Component Corporation at Soleta, California, which, as its name suggests, provides a hum indication of the circuit continuity. An additional off-the-shelf possibility is the "break wire" personnel alarm developed to provide an alarm "fence" around temporary camps.

This device is small, inexpensive, and could be used by attaching to the concertina wire on the more permanent perimeter defense. Its principle of operation is the same as that described above, and it gives an audible signal when the wire is broken.

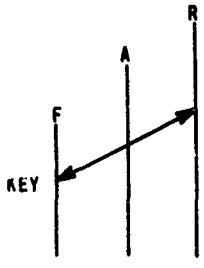
Yet another commercially available device combines the continuity circuitry principle with sensors that detect movement of the wire. Called "Perim-Alert," this intrusion detection system was designed to indicate at a remote location any significant disturbance of the fence. The monitor box contains both an audible and visual signal and the system sensitivity is adjustable to reduce false alarms caused by wind, birds, etc., disturbing the wire. The manufacturer is Air Space Devices, Inc., Paramount, Calif.

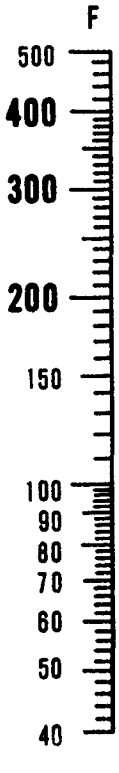
E. Communications Interference Study. This study was accomplished per request of the Commander, Beach Jumper Unit #2, Norfolk, Virginia, as an information-decision aid to the conduct of the unit mission during certain fleet operations. Because of its classified nature, it is not further discussed here. The detailed report is provided as ANNEX C hereto, but only in selected copies as noted in the distribution list.

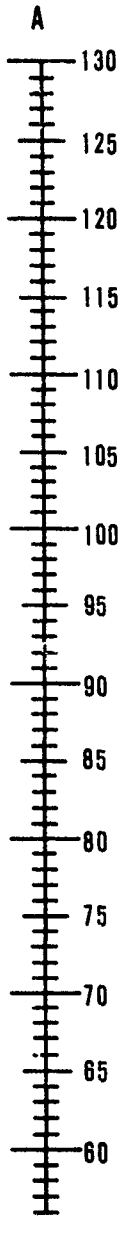
F. Communications Interference Nomograph. As a result of the study mentioned above, the Commander, Beach Jumper Unit #2, suggested that a range of interacting technical and operational parameters might be displayed in some matrixed form for quick reference by fleet operations officers. This was accomplished via the development of the accompanying nomograph. It should be pointed out that this nomograph is applicable to only certain operational and technical postulations. A second, more expansive version which will

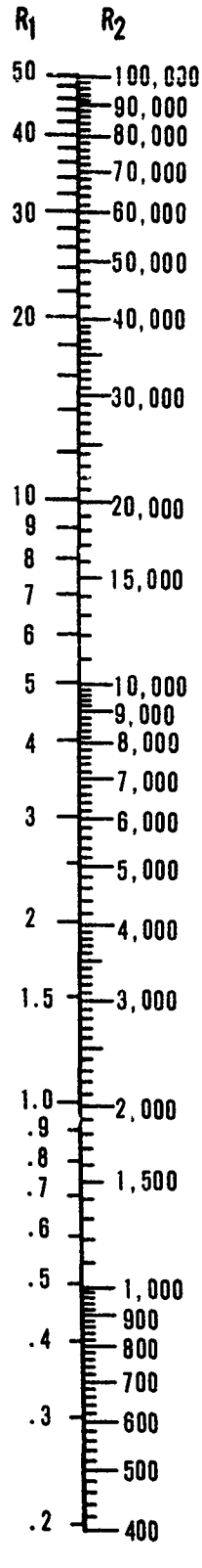
SCALE F (FREQUENCY IN MHz)
SCALE A (ATTENUATION IN db)
SCALE R_1 (RANGE IN N.M.)
SCALE R_2 (RANGE IN YARDS)

SOLUTION OF
$A = 20 \log \left(\frac{4\pi R}{\lambda}\right)$









INSTRUCTIONS:

1. ENTER THE FREQUENCY (F) AND RANGE (R) SCALES AND MARK THE APPLICABLE POINTS FOR ONE TRANSMITTER.
2. CONNECT THESE POINTS WITH A STRAIGHT LINE. NOTE VALUE WHERE LINE CROSSES ATTENUATION (A) SCALE.
3. REPEAT FOR SECOND TRANSMITTER AND OTHER TRANSMITTERS WHEN APPLICABLE.
4. COMPARE VALUES OF ATTENUATION. THE HIGHER THE ATTENUATION VALUE, THE WEAKER THE SIGNAL.

OPERATIONAL COMMUNICATIONS INTERFERENCE NOMOGRAM

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encompass most of the operational and technical variables attendant upon Beach Jumper operations is in research at this writing.

G. Camouflage Net/Sandbags. These two items are listed together as problems because existing materials are prone to rapid deterioration in Vietnam's humid, tropical climate and because they were pointed out simultaneously as problems by USMC personnel at the Landing Force Development Center, Quantico, Virginia. In addition to the rapid rotting, the current camouflage netting is extremely heavy and bulky, occupying more space and requiring more manpower to move than the weapons they were intended to screen.

Once again, in trying to match problem with solution, Poorboy investigations led to off-the-shelf commercial items which are readily available as interim solutions until full scale research can provide perhaps more sophisticated answers.

In the first instance -- camouflage netting -- the most likely substitute for the existing unsatisfactory netting proved to be a product used by commercial fruit growers to spread over fruit trees to protect the fruit from birds. Designed to be used out-of-doors for several years if necessary, the material is nylon net woven into 25 mm interlocking hexagons and impregnated with lamp black or other pigment to reduce deterioration from sunlight. The nylon is strongly resistant to rot and mildew. Equally, and perhaps more, important the material is very lightweight and can be packaged into small space; one commercially available piece of 9 by 21 feet weighs a scant 8 ounces and can be stuffed into a package the size of a cigar box. Poorboy tests show that tear resistance is not high, although an extraordinary force was required to tear the material.

As an off-the-shelf, interim capability, this material most nearly

satisfies the basic problem. Cuttings from the 9-by 21-foot piece examined by Poorboy researchers are available upon request, together with information about source.

As to the sandbags, some research has been accomplished under OSD(ARPA) direction with plastic bags. It was found that though these bags did not rot as rapidly as the older natural fibre type, they did deteriorate from the sun and also they slipped across each other, making stacking difficult. Project Poorboy investigations into this subject revealed another possibility. This is a plastic material reinforced with nylon webbing used as building enclosures, pit liners, shipping covers, and pit silo covers. The material is available in dull green and black which provide excellent resistance to sunlight deterioration. The waffle effect resulting from the internal webbing overcomes the tendency of plastic to slip. Since the material is designed for outdoor use, including use with corrosive materials, and since it combines high tear and burst strength with lightness and resistance to rot and mildew, it would appear to be a suitable alternative to the existing sandbags which require replacement every 30 to 45 days under the climatic conditions of Vietnam. Cost figures for large quantities of prepared bags (with an attached plastic tie) were not available to Poorboy researchers, but are expected to be only slightly higher, if at all different, from that of the existing natural fibre bags. Limited sample pieces are available upon request, together with information as to source.

H. Drop Cargo Beacon/C-Ration Heater/Glow Panel Marker. These three investigations are grouped together because they have in common two characteristics: They each originated in earlier years' Poorboy research and each is now the

subject of possible prototype production and, hence, no longer under the proper purview of Project Poorboy. They are here reported, however, as a matter of interest and because of their earlier Poorboy connection. Briefly, the Drop Cargo Beacon was a suggested scheme using an electronic (later, an acoustic) beacon as an aid to finding aerial resupply drops when they fell into jungle or tall grass in Vietnam. The C-Ration heater was a scheme using exo-thermic chemicals to warm C-Rations as a morale device for foot patrols in Vietnam. The glow panel marker was a suggested scheme using chemical or electroluminescent panels to mask drop zones and/or to indicate to air support forces the direction and distance of a desired strike.

All three ideas are under consideration by the U. S. Army's Limited War Laboratories. Personnel at that laboratory have expressed an especial interest in the ultrasonic bundle locator.

I. Minimum Intensity Field Light. In a period when great attention is being given to strong lighting, including xenon search lights and high intensity battlefield illumination flares, the enunciation of the problem of providing a minimum intensity light for night briefing of patrols, for use in CP's, and as a general, but low-level, illumination in operations centers was somewhat of a surprise for Poorboy researchers. As reported by USMC personnel at the Landing Force Development Center, Quantico, Virginia, even the ordinary hand flashlight is too bright and too concentrated to be below the detection threshold of the Viet Cong at night.

The solution to this problem resulting from Poorboy research was the use of electroluminescent panels. The extremely thin, lightweight panels are used extensively as nightlights throughout the United States. In normal use their lifetime under continuous use is measured in years, rather

than days, and their power requirements are negligible. In the use-form resulting from Poorboy research each panel's lifetime is limited by the light output intensity which drops off to about 75% of the original after 400 hours of continuous use. At this point the intensity is at a marginal use-level. Laboratory checks and calculations using a 4 by 5 inch panel indicate that this 400 hours of use can be achieved with a single set of four ordinary D-cell flashlight batteries.

Laboratory experiments have shown that map reading (of tactically-scaled, colored maps) is possible by persons with normal eyesight with only this illumination. In addition, the intensity at the face of the light box is sufficient to permit read through of maps on ordinary map paper. Aerial photos are also readable in both positive and transparency when laid over the screen.

In addition to the electroluminescent panel and batteries, an oscillator and a transformer are needed. Poorboy research calculation and test show that the minimum operating voltage and cyclic frequency to achieve the desired level of illumination from the panel is approximately 190 volts at 120 cycles.

A feasibility prototype and demonstration model is awaiting delivery of certain components at this writing.

J. Waterproofed Acoustic Compass. This investigation is a follow-on to the research leading to a compass which provides an aural as well as a visual indication of course or heading. The audible compass originated by Poorboy research in prior years was received with great interest by various combat oriented R&D organizations It was suggested by several sources that the

USN SEALS and certain units of the U. S. Army Special Forces might find this compass in a waterproof package well suited to certain of their special operations.

Since this action was essentially a production-development effort rather than research it was considered somewhat outside the purview of Project Poorboy. However, another portion of the Poorboy contractor's facility was induced to undertake this development as a company effort. At this writing the development has been held up pending a decision to use a beta-light source in lieu of the miniature lamp and battery of the existing model.

K. Brush Cutter for Clearing Landing Zones. A requirement was stated for a device which could be used to quickly clear a landing area for helicopters in the Kunai grass of Vietnam. This grass, which grows in dense stands up to 10 to 12 feet in height, precludes helicopter landing to evacuate wounded, to bring in supplies, etc. When it must hover above ground and use a winch to bring in wounded it becomes an ideal target for small arms fire. Machetes were too slow and too readily dulled to suit the purpose. (Kunai grass exudes a crystal silicate which rapidly dulls the edge of the issue machete.)

Once again, a commercial product was found by Poorboy researchers to best provide an interim solution. The recommended device is usually referred to as a brush cutter or a brush and weed cutter. Completely portable and self-contained with an air cooled, gasoline powered, 2 to 3 horsepower engine, the unit is supported by a strap over the shoulder and is operated by a man standing upright. From the motor a single hollow shaft extends to the cutting head, the power being transmitted via a flexible cable inside the hollow shaft.

The cutting head has three cutting faces rotating against a stop bar. The cutter is of high quality alloy steel, although a tungsten carbide cutting edge would add an even greater advantage over the machete.

Total weight is about 30 pounds. It is estimated that two men using these cutters can clear a landing area for a Chinook size helicopter in 15 to 30 minutes. Source information is available upon request.

L. Dowsing as a Technique for Detecting Viet Cong Tunnels. The problem of detecting and locating Viet Cong tunnels has been so frequently stated that it needs little iteration here. One approach to this problem was suggested to Poorboy researchers based on the successful use of the "art" of dowsing by members of the local cave exploring group over the past several years to locate new caves (including those with no surface opening) for exploration. A detailed report of this investigation is given at ANNEX D hereto.

The conclusions reached suggest that a measurable relationship may exist between the art of the dowser and the detection of tunnels (and possibly certain kinds of buried or hidden objects). Though the evidence suggests such a connection, further research will be needed to either confirm or deny this possibility.

The report (ANNEX D) notes the use of this technique by combatant forces in Vietnam in the absence of any other useful aid for this purpose.

ANNEX A

LOW FREQUENCY VIBRATION

Its Physiological and Psychological Effects on the Human Organism

H R B - S I N G E R , I N C .

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LOW FREQUENCY VIBRATION

Its Physiological and Psychological Effects on the Human Organism

A Literature Review

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January 1968

A SUBSIDIARY OF THE SINGER COMPANY

I. Introduction

The task has been to discover the available literature on the effect of low frequency sound and vibration on the human organism. Low frequencies to be investigated were to fall in the range roughly below 50 hertz.[1/] The effects on which the investigation were to center were those relating to psychological stress, annoyance, physiological disturbances and the like. In some cases, abstracts of articles cited were consulted in lieu of the original.

II. General Overview of Findings

The review concerned low frequency sound and vibration in four major areas: physiological effects, annoyance, discomfort, and psychological stress. Whereas body resonance seemed to be a possible explanation for the results in the four major areas considered, findings related to such resonances are also presented.

Literature reviews were consulted to provide an initial indication of the state of research in the low frequency area. Berrien (4) reports a paucity of studies relating to noise and its effects on human organisms. Early studies reported by Berrien dealt with production levels primarily and the effects of "noise" on physiological processes. Usually, "noise" versus "no noise" conditions were compared as were various intensities of noise. Noise appeared to hamper production (efficiency) and to raise the

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1/ Hertz = cycles per second.

rates of metabolic processes. Concerning annoyance, high tones, intense tones and interrupted and discontinuous noises tended to be more annoying than the reverse cases.

An extensive review by Kryter (27) contains a brief summary of annoyance feelings related to noises. In general, unexpectedness, inappropriateness, intermittency, intensity, and frequency affected feelings of annoyance adversely. Increased intensity made for increased annoyance as did increased frequency, according to Laird and Coye (28).

Physiological studies indicate that noise increases metabolic rate initially but that continued exposure results in return to a normal rate. The comment is made (27) that the responses to noise "can be classed as startle responses to an unexpected or disturbing stimulus."

Plutchik (38) reports that time estimation as well as performance may be affected by noise. In addition, it may be said that "It is evident that a high intensity noise...can be considered a stress stimulus....".

It has been shown (31) that a flickering light can affect blood oxygen saturation levels; similar results were obtained with low frequency sounds.

Some studies, to be summarized in the next section, have considered body resonances and neurophysiological findings. These findings, coupled with other findings of low frequency vibrations on behavior, show a remarkable similarity.

III. Summary of Relevant Research Findings

This section is divided into five sections: (A) Body Resonance, (B) Physiological Effects, (C) Annoyance, (D) Discomfort, and (E) Stress.

(A) Body Resonance

Research indicates that discomfort, annoyance, and actual bodily harm result from certain low frequency vibrations. Resonances of certain body organs appear to be a probable explanation for the phenomenon. Jacobs (26) reports that body organs vibrate at resonant frequencies of 5 and 10 hertz and presents a pictorial of human vibration tolerance peaking at around 5 Hz. Guignard, et al, (21) report body resonance to be 4.8 Hz, whereas White, Lang and Coerman (45) report a sitting body resonance at 4 Hz and a semi-supine body resonance at 7 Hz. Ashe (2) reports resonant frequencies of 3 - 4 hertz for abdomen and diaphram and 7 - 11 hertz for the chest-lung system in humans. Griswold, et al, (20) report a peak body resonance of 3.5 to 5 hertz. Secondary and tertiary resonances occurred at 6 - 14 hertz depending on the build of the subject. Lockle (30) indicates a resonance between 4 and 10 Hz in his experiments. A review by Goldman and von Gierke (18) reported resonant frequencies of 4 - 6 Hz for sitting man, 3 - 3.5 Hz for the supine position and 5 and 12 Hz for standing man.

The various frequencies reported for body resonance all fall below 15 hertz. The differences among various studies appear to be due to shake-table configuration, harnessing techniques, body position, and similar factors. That body resonance and resonances of certain body organs fall below 15 Hz (primarily around 3 - 7 Hz) is certain.

(B) Physiological Effects

Hornich and Lefritz (24) report an initial increase in heart rate

and respiration with the presentation of stimuli but both return to normal following repeated exposure. No specific frequency data are given although a 1 - 12 Hz band was used in the experiment. Guignard, et al, (21) on the other hand, indicate a significant increase in breathing rate at 2.4, 4.0, 4.8, and 9.5 - 13.5 Hz (± 1/4 g acceleration was used). Duffner (15) studied breathing rate during 2 - 7 Hz vibrations at various accelerations between 0.15 and 0.35g. Hyperventilation was most pronounced at 4 - 5 Hz. He also discovered that O_2 consumption increased toward the lower frequencies. Vital capacity was not changed. Lovett Doust, Hoering and Schneider (31) measured O_2 saturation values in arterial blood as a function of flicker frequency (light). A depression was found in O_2 level at 3 - 9 and 12 - 17 Hz; no change was found at 9 - 11 and 18 - 22 Hz. The experiment was repeated using a low intensity auditory stimulus (frequency not specified) and similar results were obtained. Lovett Doust and Schneider point out elsewhere (38) certain neurophysiological periodicities of 5 - 10 Hz, intimating a possible connection.

Ernsting (16) reported greatest gastric pressure at 3 hertz as well as a marked increase in pulmonary ventilation during vibrations of 1.7 to 9.5 Hz at $\pm^1$g acceleration. A significant increase in O_2 consumption was noted at 9.5 Hz. Lewis (29) found no change in rate of heart beat at 20 Hz. Schmitz (42, 43), using a range of from 1 - 8 Hz in two studies on man and dogs, showed (a) an increase in systolic and a decrease in diastolic pressure in the aorta, right atrium, and left ventricle in dogs; (b) increased systolic pressure

in man; (c) increased cardiac output; (d) large variations in pulse pressure; and (e) no change in heart rate. Lockle (30) reported increased pulmonary ventilation at 6 - 10 Hz.

Ashe (2) reported blood sugars and lactic acid levels static at 3 - 15 Hz vibrations. After 4 hours at 15 Hz (0.25 inch amplitude) blood sugars dropped 5 - 10 mgm. At 20 Hz for one hour, sugar dropped 7 - 13 mgm and a 2.5 - 5.2 mgm per cent rise in lactic acid level was reported. A significant increase in O_2 consumption at 6 - 15 Hz was also noted.

Performance and reaction times have also been investigated. Using vibrations of 1.5, 2.5, 3.5, 4.5, and 5.5 hertz at intensities of 0.15, 0.25, and 0.35 g peak acceleration, Hornick (23) found that low frequencies impaired performance related to the control of a vehicle. Compensatory tracking ability, choice reaction time, foot pressure constancy and peripheral vision were significantly impaired. Holland (22) found a performance increment as well as a reaction time increment, but at an increase in error. The error increase was more at 5Hz than at 2 Hz. Considering frequencies below 2000 Hz, Broadbent (7) found that low frequencies and low intensities resulted in slow initial reaction time. Schmitz (41, 43) reports a significant decrement in performance for visual acuity, compensatory tracking, and foot constancy following vibrations of 2.5 and 3.5 Hz for 90 minutes. Mozell and White (33) found that increasing frequencies beyond 8 Hz had an increasingly detrimental effect on visual performance. The effect reached a maximum between 40 and 50 hertz. Frequencies between 0 and 50 Hz with amplitudes between 0.05

and 0.16 inch double amplitude were used. Lewis (29) reported no measurable effect of 20 Hz vibration (.004 - .006 inch amplitude) on performance of the Mashburn apparatus.

The effects of vibration having to do with actual bodily harm have been studied by numerous authors, primarily in conjunction with the armed services and aircraft industries. Clark (9) showed maximum body strain in the semi-supine position to be at 6.7 Hz. Both Goldman (17) and Cope (11) report hemorrhaging in animals exposed to low frequency vibrations. Cope (11) reports unpublished findings of White and Mozel (1958) in which severe chest pain was reported at 8 - 15 Hz, 0.15 inch amplitude. Rectal bleeding (20 - 25 Hz, 0.17 in.) and constipation as well as blood in the urine (8 - 15 Hz, 0.15 in., 2.5 minutes) were reported in some subjects following exposure. Garrill and Snyder (19) reported chest pains occurring at 5 and 8 Hz. Goldman (17) used very high intensity (5 - 15 g) 5 - 20 Hz sound to produce lung hemorrhage. By contrast, Anthony, Ackerman and Lloyd (1) report no tissue damage in animals exposed to intense low frequency noise.

Ashe (2) reports on studies showing severe chest and abdominal pains occurring at 11 and 15 Hz. At 8 Hz, all Ss reported migrating transitory chest, abdominal, and/or back pains. Some rats were killed by Schaefer, et al (40) by exposure to 25 Hz vibrations (.25 in. displacement). Other vibrated rats were easily hurt and some showed calcific masses in the seminiferous tubles of the testes. Pulmonary hemorrhaging and evidence of traumatic myocardial damage

were reported by Pape (36) in a study on anesthetized cats exposed to 5 - 20 Hz vibrations and 5 g acceleration.

An interesting phenomenon is reported by Berry and Eastwood (3) in studying helicopter problems. Grand mal convulsions were experienced by aircraft personnel immediately following their looking into the sun through rotating propeller blades. One of the authors of the paper experienced a "panic sensation" following similar accidental stimulation in an aircraft. It was later verified in the laboratory that photic stimulation at 10, 12, 14, and 16 flickers per second were involved. Lovett Doust, et al (31), it may be recalled, found that light flickers and low frequency sounds may produce similar physiological and psychological results. (Other research indicates, however, that light flashes are not an effective weapon [8, 12, 35].)

(C) Annoyance

Thiessen and Shaw (44) studied irritation thresholds among Ring-billed Gulls. A U-shaped curve was obtained with irritation minimal at about 400 - 500 Hz and increasing towards 100 Hz. Frequencies less than 100 Hz were not studied. Pollack (39), studying humans, found both "very low" (60 - 175 Hz band) and "very high" (4900 Hz and up) frequencies more annoying than the middle frequencies. Parks (37) using human subjects on a vibrating chair at frequencies between 1 - 27 Hz found that the lowest intensities said to be annoying occurred at 5 - 6 Hz.

In other realms, Goldman (17) comments that one can withstand exposures for 5 - 20 minutes of up to 20 Hz at 1 g acceleration

without discomfort. Miller (32) found a wide range of frequencies more annoying than a narrow range and both brief pulses and random patterns more annoying than steady or regular patterns of noise. Broadbent (6) agrees with Miller (32) in reporting that a rhythmic rather than an evenly repeating tone is more annoying. He also reports that an inappropriate noise is annoying.

An early (1929) study by Laird and Coye (28) using a paired comparison method found 64 Hz vibrations more annoying than 256 Hz and up except for those vibrations above 2048 Hz. 64 Hz was the lowest frequency studied. Ziegenruecker and Magid (46) investigated tolerances to various frequencies. Least tolerance was found between 1 and 2 g at 3 - 4 and 7 - 8 Hz. Subjects reported boredom and/or a pleasant experience at 0.06 in. amplitude at 2 and 4 Hz according to Ashe (2). He also reported 2 Hz (0.3 in. ampl) very pleasant; 6 - 8 Hz, Ss very tense and fatigued; 11 - 15 Hz, Ss complained of transitory trunk pains. Schaefer, et al, (40) reported that rats were more irritable following vibration at 25 Hz (0.25 in.).

(D) Discomfort

The distinction between discomfort and annoyance is important; annoyance refers to a psychological state, discomfort is more a physical one. But research results show similar trends. Jacklin (25) reports results from an earlier study in which a constant, K, was determined ($K = Ae^{0.6F}$ where K = constant, A = maximum acceleration in ft/sec^2, F = frequency in hertz, and e = 2.718). He found that the K tolerated in vertical, longitudinal, and transverse vibrations are as follows:

	Vertical	Longitudinal	Transverse
Uncomfortable	64.7	11.73	8.21
Disturbing	31.2	4.02	2.35

The frequencies at which the lowest accelerations were found most disturbing were:

Vertical	Longitudinal	Transverse
5 & 10 Hz	2, 5, 7, 9 Hz	1, 4, 8, 14 Hz

Holland (22) reported in a literature review section of a report that low frequency sinusoidal vibration in the 2 - 6 Hz range increased discomfort. Berry and Eastwood (5) refer to a study by Goldman (private source) in which a "zone of unpleasantness" is defined in the 25 - 75 Hz range. Garrill and Snyder (19) report 15 Hz as uncomfortable (referred to a "vibrating larynx").

(E) Psychological Stress

Little has been reviewed relating low frequency vibrations to stress. However, some studies reported earlier show results pointing to stress-like causes. Schaefer, et al (40), report a study on rats vibrated at 25 Hz (.25 in. displacement) in which it is noted, as possible indications of stress, that vibrated animals ate less, needed more food to maintain body weight, and were more irritable and more easily hurt than the control animals.

Davis (13) studied community reactions to aircraft noises and found that 80 percent of those polled who had complained about aircraft noises also had some fear in connection with aircraft. Barrett (3) found a similar phenomenon in that those who complained about high

intensity sound (105 - 110 db) tended to be more insecure, inhibited, and lacking confidence. He concluded that nausea, headache, and other somatic complaints of Ss might be from sound induced stress.

Nixon (34) discovered poor voice communication and mimicry of frequencies when Ss performed under 10 - 25 Hz sound. Ten hertz was the worst.

IV. Conclusions

Representative findings were presented from among the available literature. It has become evident that frequencies near the body resonances, and in any case those below 15 hertz serve as stimuli for behavioral changes, somatic complaints, and annoyance. A clear pattern does not emerge, however, as to specific cause-effect relationships due to the small sample of studies (or small population rather) and differing experimental conditions.

It appears that pathological changes occur when low frequencies are coupled with sufficient amplitude. It appears that discomfort and annoyance coincide with exposure to low frequency sound and vibrations.

It is necessary to report that the greater number of studies reported were carried out on some type of "shake table" apparatus. Amplitudes tended to be high. As a result, the conclusions to which research efforts lead must be tempered by the applications to which the results may be put. It is a far cry from the shake table to a woofer.

Part V (which follows) is a listing of references which were inspected in this review. Appendix A lists those articles of possible interest which were unavailable for review.

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APPENDIX A

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ANNEX B

AREA DENIAL AND INTRUDER DETECTION METHOD

PROJECT POORBOY

AREA DENIAL AND INTRUDER DETECTION METHOD

By:

L. L. Hargenrader

July, December 1967

ABSTRACT

This paper describes a method by which personnel movement through an area can be hindered or denied. The method involves impregnating an area with minute glass fibers which cause extreme discomfort and possible incapacitation upon contact with the skin. Another use of this method is for identifying personnel who have moved within the impregnated area.

I. INTRODUCTION

Since the outbreak of the Vietnam (VN) conflict the U.S. military has been searching for methods to stop or deter North Vietnam (NVN) troop and supply infiltration through the Demilitarized Zone (DMZ) and various jungle routes. More recently, the U.S. has been searching for techniques and/or equipment which would harass or deter activity within the DMZ.

II. DESCRIPTION

Presented on the following pages is an anti-infiltration method which will discourage infiltration by area denial, will eventually make an infiltrator obvious, and will incapacitate an infiltrator for short periods of time. Basically, the method involves sowing an area with small spun glass fibers. The fibers pervade the extremities, clothing, eyes, and food of the infiltrator as he passes through the area. The infiltrator is not immediately aware of this pervasion but within a few minutes, when any activity is involved, he is physically irritated. Attempts to remedy this condition will only worsen it.

A. Material

The material used in this anti-infiltrator method is spun glass fibers approximately 0.005 inches in diameter and not more than 0.25 inches long. (A sample has been provided to the USMC Landing Force Development Center, Quantico, Virginia. The trade name of these fibers is Filter Floss.) Random lengths of less than 0.25 inch are also desirable since this will enhance both physical contact probabilities and deployment.

B. Deployment

The type of container used for storing the glass fibers is determined by the desired method of deployment. Several methods are:

1. Artillery and Mortar Shells. Shells designed for either air burst or ground burst can be used to transport and distribute the glass fibers in close range applications.
2. Air Drops and Bombs. Packages with an explosive charge for burst and distribution or bombs can be used to concentrate the glass fibers in areas where ground surface coverage is desired.
3. Low Flying Aircraft. Dissemination over a large continuous area, a roadway, or a foot trail can be accomplished best by aircraft. Several suggestions are:
   a. Low flying fighter-bomber aircraft equipped with wing tank dispensers for limited distribution along a trail or roadway.
   b. Low flying cargo aircraft for area saturation or for saturation of a trail or roadway. This type of distribution would seem to offer the best results since the aircraft could follow closely the turns of a route and the terrain.
   c. Mixed with a defoliant, this method of dissemination would seem most advantageous for a large area since the aircraft would make several overlapping passes on such missions. This would probably be the best method for saturating a DMZ.

III. PRINCIPLE OF OPERATION

A. Distribution

Assume that an aircraft has just dropped a bundle of glass fibers which contains an explosive charge set to detonate at approximately 200 feet above the surface. This burst distributes the glass fibers over an area approximately 100 meters in diameter.

The glass fibers settle upon the trail, the trees, and the undergrowth. When troops pass through the saturated area, glass fibers will fall on them due to disturbance of the underbrush and small breezes disturbing the tree-tops. Also, disturbance of the grass or dust on the right-of-way will cause fibers to pierce the feet of infiltrators -- especially if they wear sandals. Small fibers in the air will attach themselves to any exposed area of the body, especially if it is moist.

B. Physical Contact

Any fibers which contact the body will immediately cause the victim to itch and scratch. Most attempts to relieve this situation will cause the fibers to puncture the skin. Once this happens, it is practically impossible to remove the fibers. Additional movement through the area will cause more fibers to contact the body, thereby aggravating the victim's situation. As the troops move through the area, their feet will become impregnated with the fibers. This will have no immediate effect other than discomfort, but several hours later, due to walking, the troops will experience very sore feet with some swelling due to minute cuts and infection. To increase all these effects, any low flying aircraft which would cause the troops to take

cover in the underbrush would cause these troops to increase body contact with the fibers. Rain gives an additional probability for impregnation since water-laden fibers will wash from the foliage onto the troops.

Any contact a victim makes with his eyes, such as rubbing or touching them, will cause the fibers to penetrate the eyes. This will cause extreme discomfort and any additional rubbing will aggrevate the condition.

C. Results of Contact

These fibers are not immediately harmful to the body tissue but due to discomfort and the accompanied rubbing, the fibers will penetrate the skin. This will cause extreme additional discomfort and, depending upon sanitary conditions, can cause local infections thereby incapacitating the victim. If the victim gets fibers in his eyes he will soon become temporarily blind. The important features here are: pervasion of a body is unknown until it is accomplished; any attempt to relieve the situation will only aggrevate it; fibers can only be removed from sensitive areas such as the eyes by delicate surgical methods; if fibers permeate food and are ingested the victim will develop small stomach ulcers or receive infectious microscopic lacerations of the intestines. Regardless how the victim is impregnated, he will experience extreme discomfort and may incapacitate himself either due to the discomfort or his attempts to relieve his discomfort.

D. Additional Effects (Civilians)

Civilians who either assist the troops or pass through the impregnated areas themselves will also become impregnated. Civilians who give aid to victims may not be badly impregnated but recognition of these civilians can

be accomplished by inspecting the persons' hands for small glass fibers imbedded in the skin. A large magnifying glass and bright sunlight should be sufficient for this purpose.

IV. COUNTERMEASURES

There are no effective countermeasures to this procedure.* A person who does become impregnated can only hope to minimize his discomfort by remaining relatively motionless and refraining from rubbing his body. The best method of removing loose fibers from the body is by lying in a stream or standing in a shower while removing the clothing. Clothing can be cleansed by thoroughly beating, to insure all the fibers are pulverized, and by very vigorous scrubbing. All glass fibers can never be removed from the material. Fibers which penetrate a person's skin can be removed only by a tweezer and magnifying glass or by waiting until the penetrated area becomes infected and the splinter is forced out by the infection.

V. TESTING

Only simple tests have been conducted using commercially obtained glass fiber. These tests included:

A. Fiber Size vs. Penetration

Indications are that short fibers, 1/4 inch long or less, will

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* A commercial preparation called "Invisible Glove" affords "protection against irritation from...rock wool and fiberglass." This invisible spray is manufactured by Crown Industrial Aerosols, Hebron, Illinois. Whether or not this substance would be feasible for covering the entire body as well as clothing has not been determined.

penetrate the skin more quickly than long ones. Longer fibers will only scratch and irritate the skin. Long fibers will also wash away more easily.

B. Fiber Deployment

Fibers were scattered on bushes to determine if the foliage would retain them. The long fibers became entangled or were blown away quickly and remained suspended in the air for shorter periods of time.

C. Fiber Density vs. Contact

Fiber density could not be determined since only a small amount of material was available. A very low density will cause extreme discomfort which lasts for several days to several weeks.

VI. CONCLUSIONS

Short glass fibers sprayed or dropped on the foliage along a path or trail will become attached to passersby via the small air currents created by body movement. Within several steps after contact, the fibers penetrate clothing and skin. Short fibers blown or rubbed into the eyes will be extremely dangerous and can cause temporary blindness.

The material is detrimental to troop moral, discipline, comfort and health. Further, it marks the intruder for later identification.

The glass fiber material is inexpensive, easily manufactured and transported, and easily deployed.

Metalized glass fibers (chaff) will not perform as well as plain glass fibers; the metal coating dulls the glass fiber edges.

Psychological side effects can be lasting and incapacitation is mostly self-inflicted.

ANNEX C

RADIO INTERFERENCE AND ANTENNA INVESTIGATION

FOR BEACH JUMPER UNIT #2 (CONFIDENTIAL)

NOTE: This Annex is furnished separately so that the balance of the report may be treated as unclassified. This Annex is furnished only with copies numbers 1 and 2, but will be furnished to other addressees upon request and upon establishment of their need-to-know.

ANNEX D

THE UTILITY OF DOWSING
AS A MEANS OF DETECTING VIET CONG TUNNELS

THE UTILITY OF DOWSING

AS A MEANS OF DETECTING VIET CONG TUNNELS

By:

Richard K. Bossart

Revised April 1968

ABSTRACT

This paper relates to the problem of detecting Viet Cong tunnels in South Vietnam. Specifically, a method for detecting and locating these tunnels as well as other concealed objects such as pipes, wires, and other metallic devices, is described herein. Results of limited company investigations and suggestions for additional research are included in this report.

THE UTILITY OF DOWSING AS A MEANS OF DETECTING VIET CONG TUNNELS

I. THE PROBLEM

The use of tunnels and underground complexes by the Viet Cong in South Vietnam continues to pose a severe challenge to U.S. combat forces. The problem of detecting and locating these tunnels is so critical that Dr. John S. Foster, Defense Director of Research and Engineering, highlighted it as one of the leading problems facing our military forces in S. E. Asia, in an appeal to the R&D community for greater support.[1/]

Despite Dr. Foster's appeal and despite the considerable attention on the part of the R&D resource of the nation, the problem remains. "Charlie" still pops up out of his hole in the ground to ambush U.S. and ARVN soldiers, only to disappear back into the earth when counter action is initiated. In addition to serving as a sanctuary, the tunnel complexes provide the enemy with a convenient, secure storage and supply network, assembly points, command posts, training and indoctrination facilities, hospitals, bivouacs and sally ports. The evidence suggests that this network of underground installations which has been under construction for more than twenty years is an even better base for communist guerrilla activities in S. E. Asia than was Castro's Sierra Maestra range in Cuba.

1/ Dept. of Defense Film SFP-1654 "Toward Victory in Vietnam" Conf.-Gp. 4, April, 1967.

In the absence of any tunnel detection system or devices which are operable outside of a laboratory, and faced with the realization that destruction of the Communist ability to wage guerrilla warfare in South Vietnam is heavily dependent upon denying "Charlie" his bases, some of the U.S. Army and Marine units in Vietnam are attempting to solve the problem with "unproved" systems. One such attempt is that of using "dowsing". Both army and marine commanders in the field are reportedly using this technique, with unknown success.1/ Undoubtedly, any system that offers some promise of improving the odds above pure chance of discovering and locating the enemy is worth a try - if nothing else is available.

This situation, however, poses a problem in itself, for the commander knows little of what to expect from such a system for finding tunnels; nor does he have any basis for optimizing the methodology to increase the probability over pure chance of detecting Viet Cong tunnels - if such is indeed inherent in the "art" or "science" or "gift" of dowsing.

II. FACTORS BEARING ON PROBLEM

There are a number of factors to be considered in approaching this problem. Most important is that the subject -- dowsing -- is surrounded by an aura of controversy notable for the vehemence with which both its supporters and detractors advance their arguments.

1/ Informal information from presentation by Mr. Boris Sheleg (Naval Radiation Lab) on his findings in Vietnam to a Nov. 14 symposium at the University of Illinois, sponsored by USAF Avionics Laboratory. Confirmed Dec. 7 by Mr. Fred Edwards, ARPA, DDRE.
The Associated Press on 4 March 1968, also reported that U.S. Marines at Khe Sanh, Vietnam, were using bent brass rods in attempting to locate enemy tunnels.

Several other related factors, however, tend to ameliorate this situation. These include: (1) the fact that detecting and locating tunnels is so critical that the niceties of scientific rigor can be de-emphasized, if necessary, (2) the fact that dowsing is being used by U.S. forces in Vietnam (making the question of "why?" somewhat academic), and (3) an increasing acceptability of dowsing by at least some members of the scientific community as a result of the emergence of plausible theories to explain this phenomena.1/

1/ British scientist, Gordon Rattray Taylor, writing in the November, 1967 issue of Science Journal (LLIFFE Industrial Publications Ltd., Dorset House, Standford, London S.E. 1) stated the situation with some clarity as follows:

> "If there is one subject which lies precisely on the borderline between the scientifically acceptable and superstition, it is the art of the dowser -- the man who finds water and sometimes iron objects with a divining rod. For many centuries his skills have been widely accepted as valid, and the British Army has long employed dowsers to find water for troops in desert regions. Yet, in the absence of any plausible scientific explanation and because the results obtained vary so much in consistency, science has remained sceptical.
>
> "Before World War 2 a number of attempts were made to study the subject objectively, but the results were confusing. More recently, I learn, a French physicist, Y. Rocard of the Laboratorie de Physique of the Ecole Normale Superieur, Paris, has made some detailed investigations which seem to throw a completely fresh light on the subject. They are described in a book 'Le Signal du Sourcier,' published in 1964 (ed. Dunod) but have not, so far as I know, been reported in English, except for a single paper in an American symposium."

Mr. Taylor continues with a review of physicist Rocard's investigation in detail and concludes by stating:

> "Whatever the explanation, it would seem well worth trying to verify the findings by repeating the laboratory experiments. The cost of doing so would be trifling. And, if confirmed, we should have opened a line of enquiry which might, I imagine, end by throwing light on other mysteries, such as bird navigation."

In any event, the appearance in recent years of plausible scientific theories to explain the phenomenology of "dowsing,"[1/] that are supported by some scientific experimentation as well as by a considerable weight of empirical evidence, demonstrates that the theories are susceptible to scientific testing.

III. DISCUSSION

Dowsing or the locating through the use of a so-called divining rod of minerals, hidden treasure, water and caves has been reported in the literature since the 1500's. Over the centuries its validity has been accepted by some and rejected by some and hotly debated by many.

> "The only thing worse than a dowser, in the geologist's book, is a fellow earth scientist who dares harbor a lingering doubt that dowsing is completely ridiculous," says Howard Meyerhoof in the 1953 October issur of Popular Science.

> "If we can do anything to rebuke the scientists and the ignoramuses who say that dowsing is nonsense, just let us know. They haven't a leg to stand on -- unless you can call stupidity a leg," states J. Grullmans in the June 3, 1954 issue of the Boston Traveler.

Even as early as 1556 the debate raged and Georgius Agricola wrote, "Since this matter remains in dispute and causes much dissensions . . . , I consider it ought to be examined on its own merits."[2/]

Four hundred and twelve years later the matter still remains in dispute even though many attempts have been made to "test" dowsing and dowsers. Most of these experiments have ended with confusing and ambiguous results. Experimenters have hidden bottles of water under platforms for

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1/ As it applies to detecting water or tunnels. The use of dowsing as a technique for detecting criminals, etc., is discounted here.

2/ Agricola, G., "De re mettalica". Translated by H. C. Hoover for the Mining Magazine, London, 1912.

the dowser to find; have had several dowsers separately dowse a given area and compare their findings; etc. The main problem with these experiments lies in the fact that the experimenters have had no real idea what was being tested and, therefore, what controls should be imposed.

More recently advances in science have greatly expanded man's fundamental knowledge to a point where subjects like dowsing which previously had to be explained on spiritual or mystic bases may now be accounted for by a more rational application of natural laws.

Two modern-day investigations are of especial interest in establishing at least statistical relationships between dowsing reactions and measurable magneto-electric occurrences. In the first of these S. W. Tromp, professor of geology, in a review of experiments on the effect of external stimuli on living matter discovered that electromagnetic fields can exert influences on cellular processes, nerve conduction and motor behavior.[1/] (This work was performed largely in the Physical and Physiological Laboratories in Leiden, Holland and in the Laboratory of Technical Physics, Delft, Holland.)

These experiments demonstrated that the presence of external fields can indeed set up unconscious motor impulses and chemical changes in humans.

Tromp demonstrated that magnetic fields' gradients in particular can be detected by human subjects and described several experiments which he performed in 1947 using artificial magnetic fields. He found that a field of less than 1.0 milli Gauss could be detected by blindfolded dowsers in every case provided that the subject is not overworked.

1/ Tromp, S. W., Psychical Physics, New York: Elsevier Publishing Company, Inc., 1949.

In addition to magnetic fields Tromp lists four other external stimuli which may cause a typical dowsing reaction. These are:[1]

1. Electric stimulation
2. Electromagnetic stimulation
3. Acoustic stimulation
4. Stimulation by volatile components

From his investigation, he found that certain control procedures were required in order that the findings might be consistent. For example, he lists the following precautions which should be taken during a geophysical survey using dowsing:[2]

> "As with a normal geophysical survey it is necessary to follow some general rules during each dowsing survey.
>
> 1. The dowser should return regularly to a few base-stations in order to be certain that changes in atmospheric conditions, etc., are not interfering with his observations. If the turning of the rod differs considerably after the dowser returns to a base point and this is not due to fatigue (which an experienced dowser can feel very easily) corrections have to be applied.
> 2. A divining rod must be used with such a device that accurate objective readings of the rate of turning of the rod can be obtained.
> 3. During each experiment the dowser must start to follow certain profile lines, without deviating to the left and right. The direction of his movement and the direction and rate of turning of the rod must be continuously recorded on the map.
> 4. The results must be plotted on the map before any interpretation is given.

1/ Ibid. p. 344.

2/ Ibid., pp. 360, 361.

5. A general geological survey of the surface soil (composition, moisture content and structure), tectonical features (folding, faulting, etc.), topography, distribution of land and water and the vegetation should be made and indicated on the map.

6. The temperature, humidity, atmospheric pressure, kind of cloudiness and light intensity (with a photo-electric cell) should be registered continuously by a second person who follows the dowser at a distance of a few metres.

7. After the profile-survey is completed and equi-rhabdomantic lines (i.e., lines connecting points with same dowsing effect) have been plotted, the lines must be checked by following the curved lines. Differences with the map must be corrected.

8. The survey should be repeated if possible on different successive days and the interpreted maps should roughly coincide. During the survey the dowser should not consult the map prepared the previous day. Maps are prepared by the topographer who is doing the surveying.

9. It will be necessary if possible, to start from a known source of disturbance (a surface fault, water well) in order to be certain what a certain turning of the rod in that particular area could mean.

10. One should establish as far as possible whether the different dowsing reactions are due to volatile stimulation (dowser could repeat the experiment by holding his breath or by using a gas mask), magnetic effects, etc."

In 1964 a French physicist, Y. Rocard of the Laboratoire de Physique de Ecole Normale Superieur, Paris, performed an experiment similar to Tromp's. In his book Le Signal du Sourcier,[1/] Dr. Rocard describes an experiment in which he established (using current carrying coils of wire) a magnetic field gradient through which his test subjects walked.[2/] Each subject was to determine the state of the field (on or off) as the current

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1/ Rocard, Y., Le Signal du Sourcier, (ed. Dunod) Paris: 1964.

2/ This is also reported by Y. Rocard in the book Biological Effects of Magnetic Fields, edited by Madeleine F. Barnothy, Professor of Physics, University of Illinois, College of Pharmacy, New York: Plenum Press, 1964; Part IV Chapt. II.

was turned on and off. Above a threshold of 0.3 mOe/m Rocard discovered that a "good subject" was never wrong in detecting the presence or absence of the magnetic field. Dr. Rocard theorized that the detection of the field gradient could be due to a natural phenomena of nuclear resonance occuring in the body in which certain molecules react to the changing field, producing a very low frequency response (approximately 1 cycle per second). In a non-uniform field, different protons in the body will have different precession rates and relaxation times. When brought together by the movement of the bloodstream, interactions may occur which are detectable. Such an explanation would have the advantage of explaining why the dowser takes no account of his orientation to the magnetic field.

Dr. Rocard determined the minimum threshold which the dowser could reliably detect as 0.1mOe/m. This is coincident with the field established on the earth's surface by electric currents resulting from water filtering through porous layers in the earth. Being at about the limit of the dowser's threshold, this could explain some of the inconsistent results obtained in many field trials while stronger gradients produced by magnetic material could explain many of the false positive indications.

It is interesting to note that both S. J. Tromp and Y. Rocard have reported success in a controlled experimental setup involving dowsers detecting artificial magnetic fields. They report that magnetic anomalies were found on the ground where a dowsing reaction had occurred. The electrofiltration and clay potential have been known and measured by

physicists for a number of years. It is the result of water flowing through a porous medium in contact with a clay surface, a condition often found at productive wells. Magnetic fields of 0.1 mOe have been calculated to exist at the surface as a result. Rocard and Tromp have demonstrated that such a field marked the lower limit of reliable detection by their subjects using dowsing methods.

One fact of particular interest was uncovered during a study of the construction of a pendulum, often used by dowsers. The cord, thread, etc., of the pendulum, according to R. C. Willey,[1/] to which the weight is attached is made such that the length from the hand to the weight is six inches. A calculation of the natural period of such a pendulum determined by R. Bossart of HRB-Singer, Inc. shows that it will oscillate or resonate at a frequency of approximately 1.1 cps.

Y. Rocard, in a calculation of nuclear resonances in the human, declares a proton in a field of 0.48 Oe would resonate at 2,000 rps. "Should the field be nonuniform," he calculates, "some of the protons of (the) body will have a speed of 2,000 rps, others, 2,001, corresponding to a variation of 0.25 mOe. These protons (the proton of the hydrogen ion in water, for example) are fixed in the bones and muscles and mobile in the blood...The circulation of the blood causes waves of mobile protons to come in contact with the fixed protons or other systems of molecules, beating at a frequency of 2,001 - 2,000 = 1 cps. No matter how weak this is from one proton to another, it becomes evident when the volume is considerable. If these vibrations (beats) play any role in living matter, for example, in

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1/ Willey, R. C., Field Dowsing Techniques and Applications, Schenectady, N.Y.; 1964. (pamphlet)

reducing muscle tone, this would suffice to cause a movement of the divining rod if it were in an initially unstable position."[1/] Should the muscles of the wrist, hand or arm flex at a 1 cps rate, the pendulum, possessing a relatively high "Q", would reinforce each flexing and result in an "amplification" of the response. Notice that the designed resonance frequency of the pendulum and the calculated "beat" frequency of protons in a typical magnetic gradient are nearly equal.

IV. RELATED EXPLORATORY INVESTIGATIONS BY HRB-SINGER, INC. PERSONNEL

Since caves and tunnels, by definition, are anomalies in the earth's crust, the possibility of discovering them by dowsing would appear to offer possibilities. This concept prompted several staff engineers and scientists of HRB-Singer, Inc., who were also "spelunkers,"[2/] to try dowsing methods for locating caves. This they did with some success as early as 1964. Therefore, the concept of applying this technique to the problem of detecting Viet Cong tunnels was a logical response once the problem became known via the film "Toward Victory in Vietnam."[3/]

Since then, additional efforts were made by the same group to further try the approach against man-made and natural cavities in the earth. These efforts are described below. Also included are references to the work of

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1/ Rocard in Barnothy, M., op. cit., pp. 279-286.

2/ Cave explorers.

3/ This film was shown to an approximate total of 550 company engineers and scientists in August, 1967.

other HRB-Singer personnel, as well as to members of the adjacent Penn State University.

J. Kingston, W. B. White, J. L. Haas, and N. E. Lambert[1/] located an "entranceless" cave (a cave without an opening to the surface) in a ridge of limestone near Burnham, Pennsylvania, using dowsing rods. With the dowsing rods a grid pattern was walked on the surface. The places where dowsing indications existed were marked with cairns of stone. Then, using earth-moving equipment, a trench eight feet wide and thirty feet long was dug, meeting the cave passage head-on in both horizontal and vertical placement.

A compass and tape survey of the cave as a check to a surface map showed reasonable agreement in passage width and trend, the dowsed cave being slightly wider than the actual cave.

Two brief experiments concerning location of underground cavities were conducted by a master's degree candidate in physics at the Pennsylvania State University and an employee at HRB-Singer. The first concerned five different persons, separately and without prior information, dowsing a given area. The purpose was to determine with what accuracy dowsing reactions could be repeated among the five persons. A site behind a duplex house in which the author lives was chosen and the first survey was made by himself without observation of the other subjects. Of the four remaining subjects, three also lived in the duplex but had never before attempted

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1/ J. Kingston, local resident; J. L. Haas and W. B. White, The Pennsylvania State University; N. E. Lambert, HRB-Singer, Inc.

dowsing. The fourth had successfully dowsed before but was not a resident of the duplex. Of the four subjects, three including the non-resident obtained dowsing reactions within approximately 1/2 to 1 meter of those obtained by the author. The fourth obtained no reactions whatsoever. Dowsing reactions coincided with what was determined to be the location of a septic tank.

The second experiment involved searching for a septic tank on a property previously unknown to the subjects. Two of the previous dowsers conducted the experiment. The test was performed on 15 November 1967. Weather conditions were as follows:

A. 1/2 to 1 inch snow cover

B. Temperature, low 20's

C. Parly cloudy skies

D. Wind gusts in excess of 10 mph from the northwest

The snow cover tended to obscure surface indications and enabled a straight grid pattern to be easily walked. Dowsing indications were marked with an "X" in the snow. Each subject walked only one grid line and returned to prevent "dowsing fatigue" and allow each subject to warm his hands. After completing the grid pattern a map of the "X's" was sketched and compared to the actual location of the septic tank which was later uncovered. The dowsed map compared favorably with the location of the septic tank, its radials and drainage field.

V. CONCLUSIONS

These experiments are by no means meant to indicate proof of dowsing. They are in general uncontrolled and subject to reasonable doubt, but they

do indicate that the subject of dowsing with respect to the location of disturbed earth such as caves and tunnels indicates some feasibility and should be further investigated through a series of carefully controlled experiments to determine:

A. The validity of dowsing techniques in this application.

B. Its reliability in the location of tunnels and caves.

C. Influences of various extraneous fields on the dowsing reaction.

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13. ABSTRACT

This report describes operational activity and technical progress under ONR sponsored Project Poorboy which is directed toward low cost, interim and quick-fix solutions to operational and intelligence problems of limited war. Because of its emphasis, solutions are characterized by their deliberate naivete, simplicity and off-the-shelf nature. Subjects addressed include locating Viet Cong tunnels, perimeter security, communications security, minimum intensity field lights, lightweight camouflage netting, non-rotting sandbag material, an area denial method, infrasound as a weapon system, a scheme for electrifying concertina wire and a cut wire alarm.

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information systems						
dowsing						
infrasound						
perimeter defense						
alarms						
area denial						
Kunai grass						
brush cutters						
acoustic compass						
communications interference						